Revision B - 9/16/98

4.0 STATEMENT OF WORK

The Pre-Phase A Mission Study at JHU/APL will follow the format provided by GSFC. GSFC and APL will provide a joint Statement of Work at the conclusion of the Pre-Phase A Study.

The primary results of the JHU/APL Study will be a spacecraft definition to support the Instrument Announcement of Opportunity and a significantly higher fidelity cost estimate for Phases A through D.

The JHU/APL tasks for this study are in the following six categories:

A. Project Management
B. Mission Design
C. Instrument Interfaces
D. Spacecraft Conceptual Design
E. Mission Integration
F. Mission Operations

A. Project Management

A more detailed schedule and cost than implied by the use of the words "top level" will be provided for both the 2002 and 2004 opportunities. The breakdown will be provided by fiscal quarters and will be itemized by spacecraft, mission integration, and mission operations.

In the spacecraft category each subsystem will have five to ten line items for both schedule and cost. For mission integration a test flow will provide the details for both schedule and cost. Mission operations, as discussed in a later section, will include both pre-launch and post-launch efforts.

B. Mission Design

The following items will be included in the Pre-Phase A study:

1. Review the single versus dual launch approaches and include STS as a candidate launch approach.

2. Examine the constraints on launch window and how they would be impacted by the launch techniques in B, above.

3. Analyze the spacecraft-sun and spacecraft-earth distances throughout the mission and their impact on mission parameters.

4. Investigate the launch parameters that affect spacecraft design (i.e., eclipse time, ground track).

C. Instrument Interfaces

The Announcement of Opportunity for the instruments needs to be out during the last quarter of calendar 1998 in order to support the earlier 2002 launch date. The preliminary spacecraft interfaces with the instruments will be derived during this study. These interfaces include: volume, mass, power, data rate, electrical interface, field of view, temperature, attitude knowledge, and attitude control.

D. Spacecraft Conceptual Design

The following items will be included in the Pre-Phase A study:

1. Identify, using previous analyses by GSFC, and further work via this study the Level 1-mission requirements. Focus on those requirements which appear to be the more significant cost drivers and examine alternative, if any, less costly solutions. An effort will be made to partition these requirements between the flight system and the ground system. For example, a significant trade study will detail the expense of the ground antenna time (DSN) versus the size of telecommunication system on the spacecraft.

2. Prepare the system block diagram; identify any redundancy and rationale. To maintain a high confidence in the STEREO cost estimate, the system architecture will be based on a single-string derivative of the redundant TIMED design with selective redundancy added. The choice of where to add redundancy is a function of the increase in system reliability and cost and the impact of any modifications to the baseline TIMED design.

3. Identify spares philosophy. A qualitative approach to spares will be presented, i.e., kits, board level, units, etc.

4. Identify configuration management level. Typical configuration management plans for JHU/APL will be provided.

5. Perform subsystem conceptual designs. Lead engineers in each subsystem will detail subsystem-level requirements and define their design solution. Preliminary component level make-or-buy decision will be made, and subsystem performance estimates given.

6. Prepare mass / power lists at the component level. These lists will also note the heritage of each component. All margins will be held at the system level, with no reserve allocated to subsystems. The goal is to maintain a 20-25% margin in power and mass at the conclusion of the study.

7. Provide a preliminary overall mechanical layout using instrument interface requirements from Science Definition Study Report.

8. Provide an estimate of the required DSN support and associated data volume per track over the mission duration. Because DSN X-band 34-meter HEF coverage is widely contested, the spacecraft will be designed to limit 34-meter HEF antenna time in preference to 34-meter BWG antenna support. The required DSN coverage during the first several months of the mission is likely to be a function of the spacecraft's distance from Earth, since the volume of data returned will be limited not by DSN coverage, but by on-board recorder capacity.

9. Review the radiation requirement on components within the spacecraft (also on instruments). A worst-case radiation total dose versus shielding material and material thickness will be provided to the lead engineers to aid in parts selection. Latch-up immunity or latch-up protection will be required. (GSFC study will be used as baseline.)

10. Review various data compression for the flight system. Assume all compression is done within the instruments during this study.

11. Identify potential new technology insertion areas and their impact on mission design and / or operations.

12. Provide list of margins on key spacecraft characteristics (pointing, link margin, mass, consumables, etc.).

E. <u>Mission Integration</u>

The Integration and Test (I&T) phase will be conducted at JHU / APL. It is assumed that all spacecraft subsystems are fully qualified prior to delivery for this phase (both functionally and environmentally). Likewise, all instruments are to be both functionally and environmentally qualified, as well as fully calibrated prior to delivery for I&T. Details of the I&T phase will be examined during the Pre-Phase A Study. A typical flow for JHU / APL I&T includes serial instrument integration. When fully assembled, this observatory will go through functional testing including electrical compatibility, DSN compatibility, fault protection verification, launch timelines, and operational scenarios. Prior to environmental tests, all deployments will be conducted and a complete functional test will be baselined. Environmental tests will include, but may not be limited to, low frequency sine vibration, thermal cycling and soak, acoustics and mass properties.

Ground support equipment for spacecraft integration and for post-launch operations will be examined during this study. Selection of the GSE architecture will be based primarily on the challenges associated with integrating and operating two spacecraft.

The instrument GSE and Science Data Center GSE interfaces to the JHU/APL GSE will be examined during this study.

The use of simulators for mission development are generally employed for:

- Instrument/spacecraft compatibility
- Mission ops training
- Post-launch operations:
    - Command verification
    - Spacecraft performance
    - Flight anomalies
    - Software upgrade testing

During this study the need for all of the above facets will be examined.

F. Mission Operations

Recent experience at JHU/APL has shown that using the same personnel and GSE architecture for integration and mission operations is a significant benefit. We anticipate using this approach on STEREO.

Generally, we do not use a significant segment of a Pre-Phase A Study for mission operations. We will, however, provide the schedule and costs requested. During Phase A/B much attention will be concentrated mission operations.

In support of the Pre-Phase A study for STEREO, the GSFC will provide:

- Radiation environment study
- GSFC Grassroots Mission Study

• IMDC study reports (Note: These are on line. We will provide during the study process as needed, not as one big delivery.)

• Manpower support from Instrument Systems Manager, Project Scientist, Mission Manager, and, on an as-needed basis, subsystem engineers.